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The purpose of this study was twofold: (1) to examine the extent of basic numerical skills deficiencies in the population of recruits bound for Apprentice Training, and (2) to examine whether selected Armed Services Vocational Aptitude Battery (ASVAB) test scores could be used to predict numerical skills performance. This project was undertaken by the Training Analysis and Evaluation Group (TAEG) and Academic Remedial Training (ART), Recruit Training Command, Orlando, as part of a larger project tasked by the Chief of Naval Education and Training in the area of improving basic academic skills. Of 293 recruits bound for Apprentice Training, more than 100 failed to pass a basic test of Navy numerical skills. Deficiencies were in the area of "application" of mathematics skills rather than in the basic numerical operations. When selected ASVAB scores were analyzed, an effective formula was derived to predict a numerical skills deficit. The ASVAB subtest score for Arithmetic Reasoning (AR), combined with Paragraph Comprehension (PC) and Numerical Operations (NO) scores, was found to be the best predictor. (Author/MP)

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TECHNICAL MEMORANDUM 81-4

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ASSESSMENT OF NUMERICAL SKILLS OF NAVY ENLISTED PERSONNEL

JULY 1981

FOCUS ON THE TRAINED PERSON

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ORLANDO, FLORIDA 32813

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Technical Memorandum 81-4

ASSESSMENT OF NUMERICAL SKILLS OF NAVY ENLISTED PERSONNEL

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July 1981

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- PNCS Roland E. Porter, Jr., Personnel Support Activity Detachment, Naval Training Center, Orlando, assisted in scheduling the administration of the Navy Numerical Skills Test.

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This project was undertaken by the Training Analysis and Evaluation Group (TAEG) and Academic Remedial Training (ART), Recruit Training Command,

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20. ABSTRACT (continued)

Orlando, as part of a larger project tasked by the Chief of Naval Education and Training in the area of improving basic academic skills.

Of 293 recruits bound for Apprentice Training, more than 100 failed to pass a basic test of Navy numerical skills. Deficiencies were in the area of application of math skills rather than in the basic numerical operations of addition, subtraction, multiplication, and division. When selected ASVAB scores were analyzed, an effective formula was derived to predict a numerical skills deficit. The ASVAB subtest score for Arithmetic Reasoning (AR), combined with Paragraph Comprehension (PC) and Numerical Operations (NO) scores, was found to be the best predictor.

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SECTION I

INTRODUCTION

The increasingly complex technology associated with the modern Navy places an added burden on the Naval Education and Training Command (NAVEDTRACOM) to insure that trainees possess the skills necessary to perform in the fleet. It is becoming increasingly apparent that many Navy recruits and "A" school students do not possess the minimal level of required skills for successful school performance. An area of growing concern is proficiency in basic numerical skills as a prerequisite for technical training in such fields as nuclear power, electricity, and electronics. Because of these concerns, a need exists for a system to formally assess the extent of basic numerical skills deficiencies in the recruit population and to plan remedial instruction as early in the Navy training program as necessary and feasible.

BACKGROUND

Most technical training programs in the Navy require at least some basic mastery of numerical skills, yet instructors often cite lack of these skills as a primary deficiency among students. Sachar and Baker (1981) reported that instructors in electronics "A" schools expected students to enter the school with an array of math skills that should have been learned either in high school or in preparatory Naval training programs. The instructors perceived that many students entering the "A" schools lacked these basic math skills, yet they spent a minimal amount of time reviewing and teaching math in the "A" school classroom (1 to 5 percent of total training time).

Up to now, the Navy's only formal attempt to help remedy the situation has been the math remediation program that is part of the Basic Electricity and Electronics (BE&E) School. Students scheduled to enter BE&E take a diagnostic math test. Students who have deficiencies in math are referred to individualized remedial math units but are not tested on these units (Sachar and Baker, 1981).

Several "A" schools are establishing their own remedial math programs. One such program at the Guided Missiles "A" School at Dam Neck, Virginia, employs a locally written screening test and instructional modules, both of which match course objectives (Foster, 1981). Forty percent of entering students receive instruction from peers (recently graduated students awaiting "C" School). Remediation is given prior to the start of the formal course. School personnel are convinced, by informal observation, that the program is reducing attrition.[1]

In view of a pervasive need for training in basic numerical skills in the Navy, the Training Analysis and Evaluation Group (TAEG) was tasked by the Chief of Naval Education and Training (CNET) to develop a Navy numerical skills workbook and associated test.[2] This work was completed in cooperation with the Chief of Naval Technical Training who contracted with Memphis State

[1] FTCS G. Foster, Guided Missiles School, Dam Neck, VA, personal communication

[2] CNET ltr N-53 of 20 Dec 1978

University. Both the test and workbook, Improving Your Navy Numerical Skills, are contained in Bowman, Jones, Kaiser, Kincaid, and McDaniel (1981) (hereafter referred to as TAEG Report No. 96). The test was designed to assess basic skills involving numerical operations as well as the application of these basic skills to Navy-related problems. The test was shown to be an effective tool to accurately identify recruits in Apprentice Training and Academic Remedial Training who needed remedial math instruction.

At present, the Navy does not have a standard method for screening recruits who have deficiencies in basic math skills. The present study used the Navy Numerical Skills Test to assess the need for math remediation in a group of recruits about to enter Apprentice Training and, in addition, explored the feasibility of using the Armed Services Vocational Aptitude Battery (ASVAB) test scores to predict math skills performance.

PURPOSE

The purpose of the study was to estimate the extent of basic numerical skills deficiencies in a sample of recruits about to enter Apprentice Training. A second, and equally important, purpose was to derive a formula based on selected ASVAB test scores which could be used to predict numerical skills performance quickly and accurately. The formula could then be used to indicate the need for further testing or for placing recruits in remedial math instructional programs.

ORGANIZATION OF THE REPORT

In addition to this introduction, the report contains two other sections. Section II describes the procedures used in the study and the results. There is a brief description of the Navy Numerical Skills Test and a report of the statistical techniques used to develop a method for screening students for numerical skills remediation. Section III contains conclusions and recommendations which will assist the Navy in identifying recruits who need remedial math instruction.

SECTION II

PROCEDURE AND RESULTS

The Navy Numerical Skills Test was administered in January and February 1981 to 293 recruits--230 males and 63 females--at the Recruit Training Command, Orlando. The recruits were in advanced Basic Training and were about to enter Apprentice Training.

The test was given without prior warning to small groups of approximately 40 recruits as part of a general briefing and took 50 minutes to complete.

NAVY NUMERICAL SKILLS TEST

The Navy Numerical Skills Test contains 50 items that are correlated with the topics and skills addressed in the remedial workbook, Improving Your Navy Numerical Skills. TAEG Report No. 96 provides a detailed description of the workbook and test.

Two forms of the test, A and B, are available. In both forms, items 1 through 24 in part I of the test assess basic numerical operations of addition, subtraction, multiplication, and division. Items 25 through 50 in part II are word problems which test proficiency in applying the operations to job situations in the Navy and financial responsibilities faced in the Navy. Form A was used in the present study.

A test score greater than 70 percent is recommended as a passing score.

PREDICTIVE DATA

For each recruit, student records were analyzed to obtain Reading Grade Level (RGL) based on the Gates-MacGinitie Reading Test, Survey D (Gates and MacGinitie, 1965), and scores on four subtests of the ASVAB. Scores obtained were from the Arithmetic Reasoning (AR), Paragraph Comprehension (PC), Word Knowledge (WK), and Numerical Operations (NO) subtests (those thought to be related to numerical skills).

Of the total sample, 213 recruits had ASVAB scores based on Forms 5, 6, and 7, while the remaining 80 recruits--68 males and 12 females--had ASVAB scores based on a newer version--Forms 8, 9, and 10. The old and new forms are comparable except that Paragraph Comprehension is a subtest of only the newer forms of the ASVAB; therefore, only 80 recruits had PC scores.

Selected ASVAB and RGL scores obtained from student records were correlated with scores on the Navy Numerical Skills Test. From the sample of 80 recruits administered the new ASVAB, test scores were entered into a multiple regression analysis to assess the usefulness of those measures as predictors of numerical skills performance.

RESULTS

DESCRIPTIVE DATA--TOTAL SAMPLE. Based on ASVAB test scores and RGLs the sample of 293 recruits who were administered the Navy Numerical Skills Test

are representative of the population of Navy recruits who enter Apprentice Training. Data collected from student records (table 1) revealed the expected lowered mean scores when compared to a recent Navy summary report.[3]

TABLE 1. SUMMARY OF DATA OF TOTAL SAMPLE OF RECRUITS (N=293) ON THE NAVY NUMERICAL SKILLS TEST, ASVAB SUBTESTS, AND READING GRADE LEVEL (RGL)

	MEAN		STANDARD DEVIATION
	Percent Scores	Raw Scores	
Navy Numerical Skills Test			
Part I	94.2	22.6	2.1
Part II	51.5	13.4	4.6
Total	72.2	36.0	11.5*
ASVAB	Standard Scores		
Arithmetic Reasoning (AR)	48.6		7.6
Paragraph Comprehension (PC)**	52.2		6.5
Word Knowledge (WK)	49.7		6.5
Numerical Operations (NO)	51.1		8.1
Reading Grade Level (RGL)	9.5		2.0

*Based on percent scores
**Data obtained from 80 recruits who had been administered the new forms of the ASVAB--Forms 8, 9, and 10

The mean RGL was 9.5 and, as expected, the mean standard scores on the ASVAB subtests were slightly below the Navy medians for all recruits. On Arithmetic Reasoning, the mean was 48.6 compared to the Navy median of 54.6. On Paragraph Comprehension the mean was 52.2 compared to the Navy median of 53.9. On Word Knowledge the mean was 49.7 compared to the Navy median of 53.2. On Numerical Operations the mean was 51.1 compared to the Navy median of 53.9.

Table 1 also shows the numerical skills performance of the recruits. On the 24 items of part I, the group's mean was 22.6 which demonstrates high

[3]Navy medians for ASVAB--Forms 8, 9, and 10--were obtained from the CMI Recruit Population Analysis Report, February 1981. Produced by Management Information and Instructional Systems Activity.

performance on basic numerical operations. On the 26 items of part II, the mean score was 13.4 which reflects a serious deficit in numerical skills application. The test results indicate that many recruits do not possess the analytical skills necessary to solve math problems. The mean score on the whole test was 36.0 (72.2 percent) which is barely above the criterion score of 70 percent. Of the 293 recruits tested, 108 (or 37 percent) failed to achieve a passing score.

Correlations of ASVAB scores and RGL with Navy Numerical Skills Test scores are shown in table 2.

TABLE 2. CORRELATIONS OF NAVY NUMERICAL SKILLS TEST SCORES OF RECRUITS (N=293) WITH THEIR ASVAB SCORES AND RGL

Navy Numerical Skills Test	ASVAB				RGL
	AR	PC*	WK	NO	
Part I	.27	.11	.10	.24	.12
Part II	.48	.31	.28	.46	.39
Total	.49	.45	.26	.50	.32

*Correlations with PC based on a sample of 80 recruits who had been administered the new forms of the ASVAB--Forms 8, 9, and 10

All correlations were significant at the .05 level ($r>.19$) except for the correlations of part I with PC, WK, and RGL (Bruning and Kintz, 1968). Part I correlates only with the ASVAB tests that measure math skills, while part II correlates with tests that measure verbal skills as well, and also with RGL. The analytical skills needed to solve word math problems (as measured by part II) are related to these verbal skills.

For the sample, scores on parts I and II were correlated significantly with each other ($r = .34$), and both are correlated significantly with the total score. For part I and Total, $r = .54$, and for part II and Total, $r = .89$.

MULTIPLE REGRESSION ANALYSIS--SUBSAMPLE. Eighty recruits had ASVAB scores on Forms 8, 9, and 10--the newest forms of the test battery. Data from this subsample were used to assess the usefulness of ASVAB scores and RGL as predictors of numerical skills performance. The data shown in table 3 describe the subsample.

TABLE 3. SUMMARY OF DATA OF 80 RECRUITS ON THE NAVY NUMERICAL SKILLS TEST, ASVAB (FORMS 8, 9, AND 10) SUBTESTS, AND READING GRADE LEVEL (RGL)

	MEAN		STANDARD DEVIATION
	Percent Scores	Raw Scores	
Navy Numerical Skills Test			
Part I	95.4	22.9	1.5
Part II	53.1	13.8	4.0
Total	73.2	36.7	9.5*
ASVAB	Standard Scores		
Arithmetic Reasoning (AR)	50.5		7.0
Paragraph Comprehension (PC)	52.2		6.5
Word Knowledge (WK)	50.4		7.2
Numerical Operations (NO)	51.2		8.2
Reading Grade Level (RGL)	9.6		2.0

*Based on percent scores

Scores on the Navy Numerical Skills Test from the subsample were similar to those obtained from the whole sample. Thirty percent failed to achieve a passing total score. Mean RGL and mean ASVAB scores were close to those of the entire sample. Correlations of Navy Numerical Skills Test scores with ASVAB scores and RGL are shown in table 4.

TABLE 4. CORRELATIONS OF NAVY NUMERICAL SKILLS TEST SCORES OF 80 RECRUITS WITH THEIR ASVAB (FORMS 8, 9, AND 10) SCORES AND RGL

Navy Numerical Skills Test	ASVAB				RGL
	AR	PC	WK	NO	
Part I	.03	.11	.00	-.01	-.13
Part II	.59	.31	.13	.30	.44
Total	.57	.45	.2	.38	.38

To examine the predictive ability of the ASVAB scores and RGL, a forward stepwise multiple regression analysis[4] was performed that first entered into the regression equation that variable which explained the greatest amount of variance in the outcome variable (Navy Numerical Skills Test total percent score). The three variables that were found to contribute most to the variance were Arithmetic Reasoning (AR), Paragraph Comprehension (PC), and Numerical Operations (NO). Table 5 shows multiple R's and the cumulative percentage of variance explained as each variable was entered into the regression equation. A multiple R value indicates how well numerical skills scores can be predicted from an optimal combination of predictors

The predictor equation that accounts for 48 percent of the variance is:

Numerical Skills Test Score (%) = .61(AR) + .44(PC) + .27(NO) + 5.5.

This equation can serve to identify recruits who need remedial math training. It can be used to predict numerical skills performance when ASVAB subtest scores are available.

TABLE 5. MULTIPLE REGRESSION SUMMARY TABLE BASED ON DATA FROM 80 RECRUITS WHO WERE ADMINISTERED ASVAB (FORMS 8, 9, and 10)

Predictor Variables	Multiple R	Cumulative Percentage Variance Explained
AR	.57	32
AR & PC	.66	43
AR & PC & NO	.69	48

[4]This is a commonly used computerized statistical procedure from Nie, Hull, Jenkins, Steinbrenner, and Bent (1975).

SECTION III

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The results of this study agree with results reported in TAEG Report No. 96. The recruits' mean Navy Numerical Skills Test scores, RGL, and ASVAB scores were very similar to means obtained from a sample of 25 recruits in Apprentice Training who were tested in early 1980 as part of a field test of the remedial workbook, Improving Your Navy Numerical Skills. In the most recently tested sample, 37 percent of the recruits failed the Navy Numerical Skills Test at the 70 percent criterion level, and 81 failed at the 80 percent level. These large percentages indicate a pressing need for early assessment of math skill deficiencies and incorporation of remedial math instruction into training programs.

The test results suggest that recruits bound for Apprentice Training are deficient in applying math skills which involve analytical reasoning rather than in the basic numerical operations of addition, subtraction, multiplication, and division.

When selected ASVAB and RGL scores were analyzed, an effective formula was obtained to predict numerical skills performance. The ASVAB subtest score on Arithmetic Reasoning (AR) is the best predictor (accounts for the greatest portion of variance), and both Paragraph Comprehension (PC) and Numerical Operations (NO) scores contribute significantly to the accuracy of the prediction.

RECOMMENDATIONS

Based on the findings of the present study, the following recommendations are provided to assist in identifying Navy recruits who may need remedial math instruction. The recommendations are especially applicable when concerned with the population of recruits entering Apprentice Training. Based on instructors' reports, the suggestions also have merit when considering those recruits bound for "A" schools.

1. The following equation, derived in this study, should be used to assess the basic numerical skills level of recruits:

$$\text{Numerical Skills Test Score (\%)} = .61(AR) + .44(PC) + .27(NO) + 5.5.$$

If the formula yields a score of 70 or less in predicting numerical skills, then administer the Navy Numerical Skills Test. If the total score on this test is 70 percent or less, consider the recruit for remedial numerical skills instruction.

2. The TAEG has been recently tasked by CNET on behalf of the Chief of Naval Technical Training (CNTECHTRA) to design and implement a CBIM system to track ART and Job-Oriented Basic Skills (JOBS) students' activity throughout their training.

The proposed CBIM system will have a data base which contains student entry records, entry level test results, and progress test results. The authors of this report recommend the math screening formula as part of the information contained in the system.

3. Revise the Apprentice Training and "A" schools programs to include a heavier emphasis on numerical skills assessment and remedial training, but only after doing a thorough needs analysis to determine the level of numerical skills training required.

4. Incorporate the remedial math workbook, Improving Your Navy Numerical Skills, into the math curricula of Apprentice Training. The workbook covers material directly related to application of numerical operations in the Navy, and this study indicates this is the area where most remedial training is necessary.

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